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**POTENTIAL APPROACHES TO THE SPECTROSCOPIC
CHARACTERIZATION OF HIGH PERFORMANCE POLYMERS
EXPOSED TO ENERGETIC PROTONS AND HEAVY IONS**

by

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The general plans for the human exploration of space over the next several decades are clearly set forth in the Space Exploration Initiative (SEI), and in the 90-Day Report. Deployment of the Space Station Freedom in the mid-1990's will be followed by a permanent presence on the moon early in the next century. A manned mission to Mars is planned during the period 2010-2020 [1].

A potential limitation to human activity on the lunar surface or in deep space is the exposure of the crew to unacceptably high levels of penetrating space radiations [2]. The radiations of most concern for such missions are high-energy protons emitted during solar flares, and galactic cosmic rays which are high-energy ions ranging from protons to iron (in the case of the higher atomic number species, the ions are highly charged as well, e.g. Fe^{+26}).

The interactions of such high-energy radiations with matter are not well understood at present. However, it is clear that the physical characteristics of the radiation fields are altered through nuclear and electromagnetic interactions when traversing bulk matter [3]. For HZE's (the high-charge, high-energy component of galactic cosmic rays), the modification in the propagating fields includes energy loss due to nuclear coulomb scattering, nuclear elastic scattering and nuclear fragmentation. In the case of nuclear fragmentation, subsequent-generation particles are formed and the isotopic composition of the transported radiation field is altered. The incident radiation may also cause electronic excitation and ionization in bulk media via collision with atomic electrons.

The development of materials for effective shielding from energetic space radiations will clearly require a greater understanding of the underlying mechanisms of radiation-induced

damage in bulk materials. This can be accomplished in part by the detailed spectroscopic characterization of bulk materials that have been exposed to simulated space radiations. An experimental database thus created can then be used in conjunction with existing radiation transport codes in the design and fabrication of effective radiation shielding materials.

Electron Paramagnetic Resonance (EPR) Spectroscopy has proven very useful in elucidating radiation effects in polymers (high performance polymers are often an important component of structural composites) [4]. One of the major goals of the ASEE term was thus to repair and to bring back on line an existing EPR spectrometer. In excess of eighty percent of the total period was devoted to this activity. The remainder of the term was committed to conducting literature searches and to program planning.

Considerable progress has been made toward meeting these goals. As of 7/30/91, the EPR system is fully operational. Literature searches are almost complete, and future activities are currently being mapped out. It is expected that experimental activity will commence as soon as the energetic (1-2 MeV) proton facility is available at NASA LaRC.

References

1. Report of the 90-Day Study, NASA, 1989.
2. Townsend, L. W., Wilson, J. W., and Nealy, J. E., "Space Radiation Shielding Strategies and Requirements for Deep Space Missions," SAE Paper No. 891433, 1989.
3. Townsend, L. W., and Wilson, J. W., "Interaction of Space Radiation with Matter," 41st Congress of The International Astronautical Federation, 1990, Dresden, GDR.
4. Ranby, B. and Rabek, J. F., ESR Spectroscopy in Polymer Research, Springer-Verlag Publishing Co., New York, 1977, pp 173-248.